REMARKS

Claims 1, 13 and 25 have been amended to correct grammatical errors and for clarity in reading. With this amendment, no new matter is introduced; acceptance is respectfully requested.

Rejection of Claims 1-36 under 35 U.S.C. 103(a)

Claims 1-36 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Garthwaite (U.S. Pub. No. 2004/0193662) in view of Ramachandran *et al.* (U.S. Patent No. 6,067,604). Applicant respectfully disagrees with these rejections for the reasons set forth below.

Base Claims 1, 13 and 25 are directed to a method and apparatus for identifying and eliminating data with irrelevant timestamps and eliminating work on items with irrelevant timestamps. See Specification, page 3 lines 19-23. In a computer application, processes may be represented by nodes that are interconnected by channels of data. Fig. 4 provides one such representation, where nodes 402 and 404 are tasks that process video frames, and node 406 receives the resulting data through channels 412 and 414 for further processing. In the flow of data, node 406 is considered to be "downstream" from prior nodes 402 and 404. In this example, node 406 can perform its task only when it has received corresponding data from both nodes 402 and 404. See Specification, page 7 lines 17-21. However, prior tasks may take more or less time to complete, so that node 406 may need to wait for some data before performing a task.

In Fig. 5, all data is given a "timestamp," which indicates the order in which it is processed. See Specification, page 6 line 28 - page 7 line 4. Connection C2 is locally dependant on connection C3, meaning that when thread (node) 506 receives data from C3, it will wait for data with the same timestamp from C2 before it proceeds (Specification page 9 lines 3-5). As a result, any data with an earlier timestamp is irrelevant because it will not be used by thread 506. This irrelevant data may include items and computations that are no longer needed, and can be eliminated to improve the performance of the application.

The present invention provides a method and apparatus for identifying and eliminating such irrelevant data and computations. In Fig. 6, a forwarding node 612 receives data items 628

(comprising data 630 and a time stamp 632) from any of the input connections 600-1, 600-2, 600-3 to upstream nodes; and these data items may be forwarded to downstream nodes through output connections 602-1, ..., 602-5 (Specification page 9 lines 26-30). The node 612 receives "forward guarantees" from each input indicating the earliest timestamp that will be sent by upstream nodes (Specification page 10 lines 16-17). The node 612 also receives "backward guarantees" from downstream nodes identifying timestamps that will not be used by those nodes. Based on these guarantees, known as the "local guarantees" 640, the node 612 determines timestamp requirements for the data. From this process, the node 612 determines the "node backward guarantee" 614 which identifies the earliest timestamp that will be used by downstream nodes (Specification page 11 lines 7-10). If a preceding node is processing data with a timestamp that is earlier than that identified by this guarantee, then this data is irrelevant and computation is wasted. By sending the backward guarantee to preceding nodes, the preceding nodes can then identify and eliminate irrelevant data, as well as conserve computations in processing this data. Likewise, a "node forward guarantee" can be sent to successive nodes to indicate the earliest timestamp to be sent from preceding nodes, thereby allowing the successive nodes to eliminate unneeded data and computational steps.

Garthwaite describes a system for removing stale entries in an incremental garbage collector. An incremental garbage collector scans areas of memory to determine if any data items are unreachable. Unreachable data is data that is no longer referenced by the program, and thus can be eliminated to recover space in the memory. A "remembered set" is an index that identifies references to data inside an area from outside the area (see Garthwaite, paragraphs 0055-0056). If no references are made to a data item, then it is unreachable and can be "collected" by the garbage collector. Garthwaite is directed to improving the efficiency of garbage collection by purging stale entries in the remembered set, so that unreachable items are not mistaken for reachable items. (Garthwaite, paragraph 0094). To identify stale entries, several techniques are described. In one method, each entry in the remembered set and each area of the memory are given a timestamp indicating when they were created. If an entry in a remembered set is older than the area to which it refers, then the entry is stale and can be purged (Garthwaite, paragraph 0146).

In another method of Garthwaite, the garbage collector uses summarized information about the area to be collected. This information includes "farthest forward" and "farthest backward" values, which identify the "oldest" and "youngest" areas referenced by entries in a remembered set. If the referenced areas are not as "young" or "old" as the current area, then those references are stale and can be scrubbed. See Garthwaite, paragraphs 0143-0145.

Garthwaite, alone or in combination with Ramchandran, does not teach or suggest the present invention as claimed in base Claims 1, 13 and 25. The timestamps in Garthwaite identify the relative age of remembered sets and the areas referenced by remembered sets, revealing whether the remembered sets are stale. In contrast, the timestamps of the present invention correspond to data and computations that are used by individual nodes of a node processing graph, as stated in Claim 1. The timestamps are compared to forward/backward guarantees to determine whether the data is required by certain nodes in the processing graph. The timestamps in Garthwaite have an entirely different application: they do not correspond to data to be processed in a node, and cannot be used to guarantee the earliest data to be sent or used by particular nodes, as stated in Claim 1 of the present application.

The farthest forward/backward information of Garthwaite are references to other regions of memory that are related to the area being collected by a garbage collector. The terms "youngest" and "oldest" refer to the ordering of areas to be collected (Garthwaite, paragraph 0143). These references bear no relation to the forward and backward guarantees of the present invention. These guarantees indicate the earliest data that will be used at successive nodes, and the earliest data that will be sent by preceding nodes. In contrast, the information in Garthwaite refers to different areas of memory to be collected by a garbage collector. No timestamps or other data are used or passed between these areas, nor is it possible to do so, because these areas are merely used as storage (See Garthwaite, paragraph 0051 and 0056).

For the reasons above, Garthwaite also does not teach or suggest returning a backward guarantee to preceding nodes as in the claimed invention. Moreover, Garthwaite has no relation to nodes of a processing graph, to which the present invention applies. The "nodes" in Garthwaite are merely a structure for storing a remembered set (Garthwaite, paragraph 0150). These "nodes" do not process data, make computations, or exchange data with other nodes, as do the nodes of a processing graph in the present invention.

One skilled in the art would find no support or suggestion from Garthwaite for the present invention because this reference does not teach or suggest "forward" or "backward guarantees", "timestamps to be used at nodes", "preceding" or "successive nodes", or applications to "nodes of a processing graph" as disclosed and claimed by the present application. Ramchandran *et al.* also does not describe any such elements, and further does not teach or suggest eliminating timestamps according to a backward guarantee. Ramchandran describes a system where data items are stored and accessed by spatial and temporal ordering, described as "space-time memory" (col. 2 lines 42-67). Ramchandran refers to eliminating threads that are "no longer needed," but here it is the node (i.e., thread) rather than the data that is eliminated, and this elimination is not based on any guarantees (col. 5 lines 55-57 and col. 6 lines 1-6). Rather, Ramchandran merely discloses marking data items as "consumed" after they have been read by a thread, after which they may be collected by a garbage collector (col. 6 lines 8-14). This marking is not based on backward guarantees, nor are backward guarantees disclosed. Thus, Garthwaite, alone or in combination with Ramchandran, does not teach or suggest the present invention as claimed in base Claims 1, 13 and 25.

Claims 2-12, 14-24 and 26-36 depend from Base claims 1, 13 and 25 and thus the foregoing applies. As a result, the § 103 rejection of claims 1-36 cannot stand and reconsideration is respectfully requested.

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

By Mary Lou Wakimura

Mary Lou Wakimura
Registration No. 31,804
Telephone: (978) 341-0036
Facsimile: (978) 341-0136

Concord, MA 01742-9133
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